

RK.L1.4 | Angular Position, Velocity, and Acceleration for Non-uniform Circular Motion | Challenge Homework

Submit a digital copy (PDF, jpg, etc.) to gradescope.com. Every page should be labeled on the top left with the question code (e.g. GR.L1.4-01) and there should be only be one solution per page. The questions should be in order. If a solution takes more than one page, be sure to label that it is a continuation of the previous page's solution (e.g. GR.L1.4-01 continued). One question will be randomly selected and graded. Challenge homework for a given week are due the following week by Tuesday at midnight. If data is needed to complete a problem, be sure to cite the source you've acquired your data from. See the course website for further details.

You will be asked to apply sense-making in most problems. Use the list below as a reference to the different sense-making techniques. More information about sense-making can be found on the BoxSand menu under Math Tools => [Sense-making](#).

- *Sign*: Check the **sign** of each quantity makes sense.
- *Dimensionality*: Check the **dimensionality** and units of each quantity makes sense.
- *Order of Magnitude*: Check the **order of magnitude** of the final answer and other important quantities is within a a factor of 10 of what you think it should be.
- *Graphical Analysis*: Use a **graph** to see if the behavior of a solution makes sense.
- *Proportionality*: Using a symbolic solution, check the behavior of the answer when you change a given quantity on which it is dependent. Does the answer vary **proportionally** to what you expect?
- *Special Cases*: Check the behavior of a derived equation in limiting (**special**) cases makes sense, e.g. as x goes to 90 degrees in $\sin(x)$.
- *Self-consistency*: Check derived equations, functions, or values, are **self-consistent**, e.g. check that the slope of a derived position plot matches the values of the given velocity plot
- *Known Values*: Compare given or derived quantities with common well **known values**.
- *Related Quantities*: Compare the relative magnitude of two **related quantities**.

RK.L1.4-01

So far in your life, you may have assumed that as you are sitting in your chair right now, you are not accelerating. However, this picture is not quite complete! You are on the surface of the Earth, which is rotating.

- (a) What is the acceleration of a person sitting in a chair on the equator?
- (b) At the equator, is your mass times the gravitational acceleration of the Earth greater than, less than, or equal to the normal force exerted on you by the chair you are sitting on? Explain.
- (c) A classmate of yours asks you why we have ignored this acceleration for the whole first term of physics. "Is everything we've learned a lie?" they ask. Assuage their fears by calculating the percentage difference between the normal force from the chair and your weight while sitting on equator.
- (d) The latitude of Corvallis is 44.4° . What is your acceleration while sitting in your chair?

RK.L1.4-02

BB8 is an intergalactic robot (essentially a soccer ball with a half meter radius that can control how fast it rolls around) that is trying out for a new role in the rebellion. One of the tests is how fast they can travel 100 m. They must start from rest and end at rest. BB8 has a maximum angular acceleration rate of 2 rad/s^2 , both when speeding up and slowing down.

- (a) What is the minimum time BB8 can run the trial?
- (b) What is the maximum revolutions per min BB8 obtains in its run?